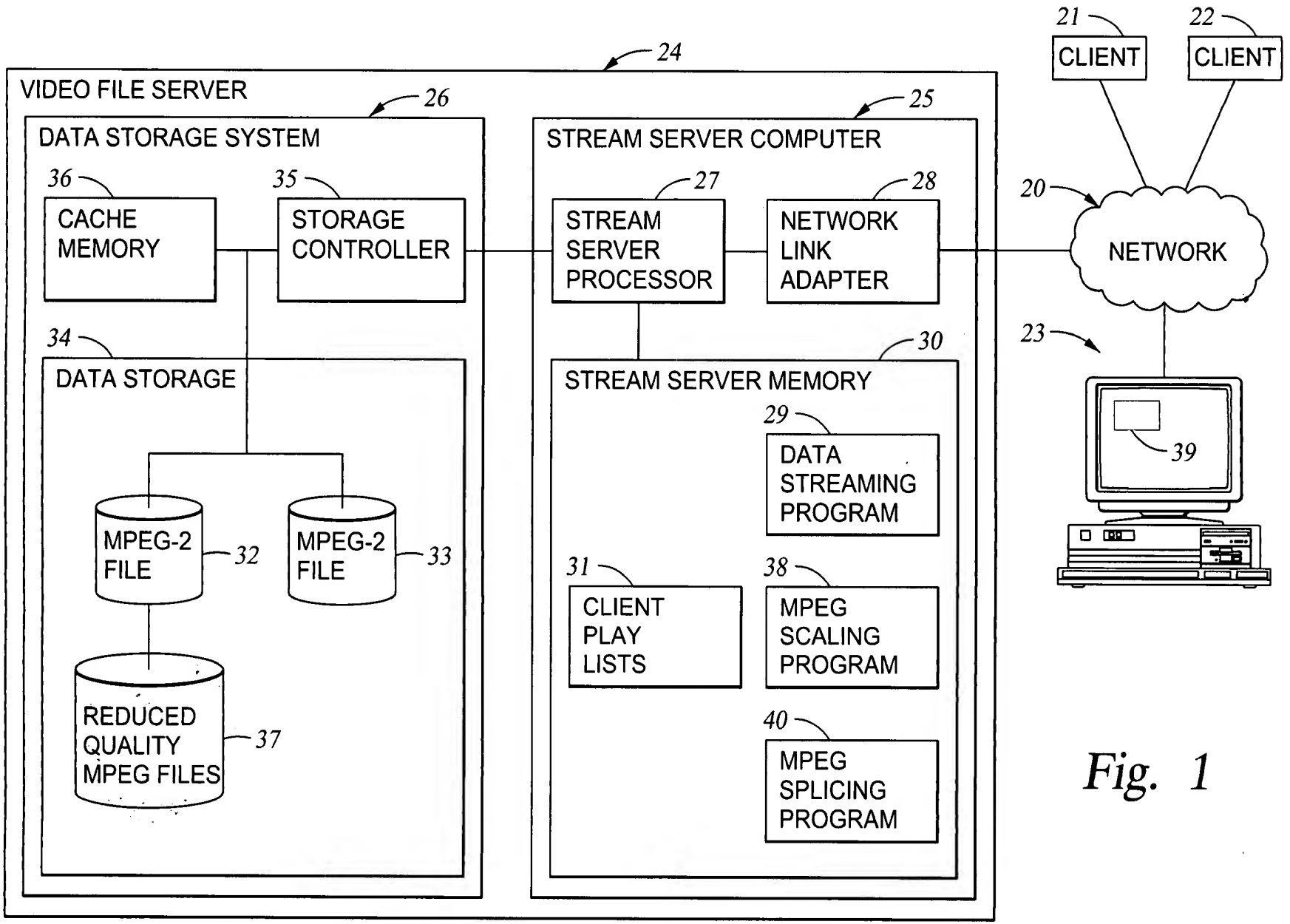
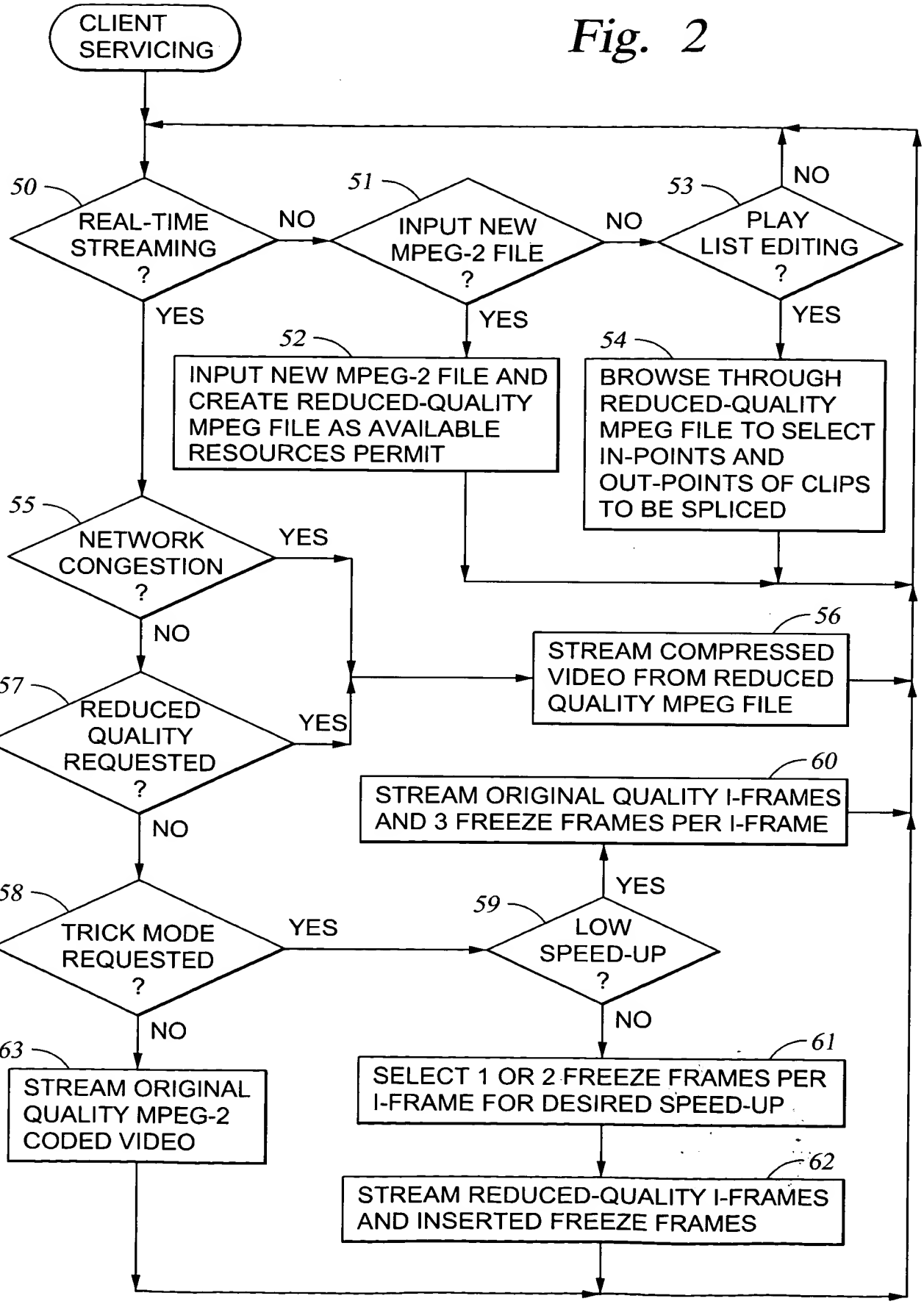

VIDEO FILE SERVER
24
DATA STORAGE SYSTEM
26
CACHE MEMORY
36
STORAGE CONTROLLER
35
DATA STORAGE
34
MPEG-2 FILE
32
MPEG-2 FILE
33
REDUCED QUALITY MPEG FILES
37
STREAM SERVER COMPUTER
25
STREAM SERVER PROCESSOR
27
NETWORK LINK ADAPTER
28
STREAM SERVER MEMORY
30
DATA STREAMING PROGRAM
29
CLIENT PLAY LISTS
31
MPEG SCALING PROGRAM
38
MPEG SPLICING PROGRAM
40
CLIENT
21
CLIENT
22
NETWORK
20
23
39

Fig. 1

Fig. 2


CLIENT SERVICING
50
REAL-TIME STREAMING ?
NO
51
INPUT NEW MPEG-2 FILE ?
NO
53
PLAY LIST EDITING ?
NO
YES
YES
YES
52
INPUT NEW MPEG-2 FILE AND CREATE REDUCED-QUALITY MPEG FILE AS AVAILABLE RESOURCES PERMIT
54
BROWSE THROUGH REDUCED-QUALITY MPEG FILE TO SELECT IN-POINTS AND OUT-POINTS OF CLIPS TO BE SPLICED
55
NETWORK CONGESTION ?
YES
NO
56
STREAM COMPRESSED VIDEO FROM REDUCED QUALITY MPEG FILE
57
REDUCED QUALITY REQUESTED ?
YES
NO
60
STREAM ORIGINAL QUALITY I-FRAMES AND 3 FREEZE FRAMES PER I-FRAME
YES
58
TRICK MODE REQUESTED ?
YES
59
LOW SPEED-UP ?
NO
63
STREAM ORIGINAL QUALITY MPEG-2 CODED VIDEO
NO
61
SELECT 1 OR 2 FREEZE FRAMES PER I-FRAME FOR DESIRED SPEED-UP
62
STREAM REDUCED-QUALITY I-FRAMES AND INSERTED FREEZE FRAMES

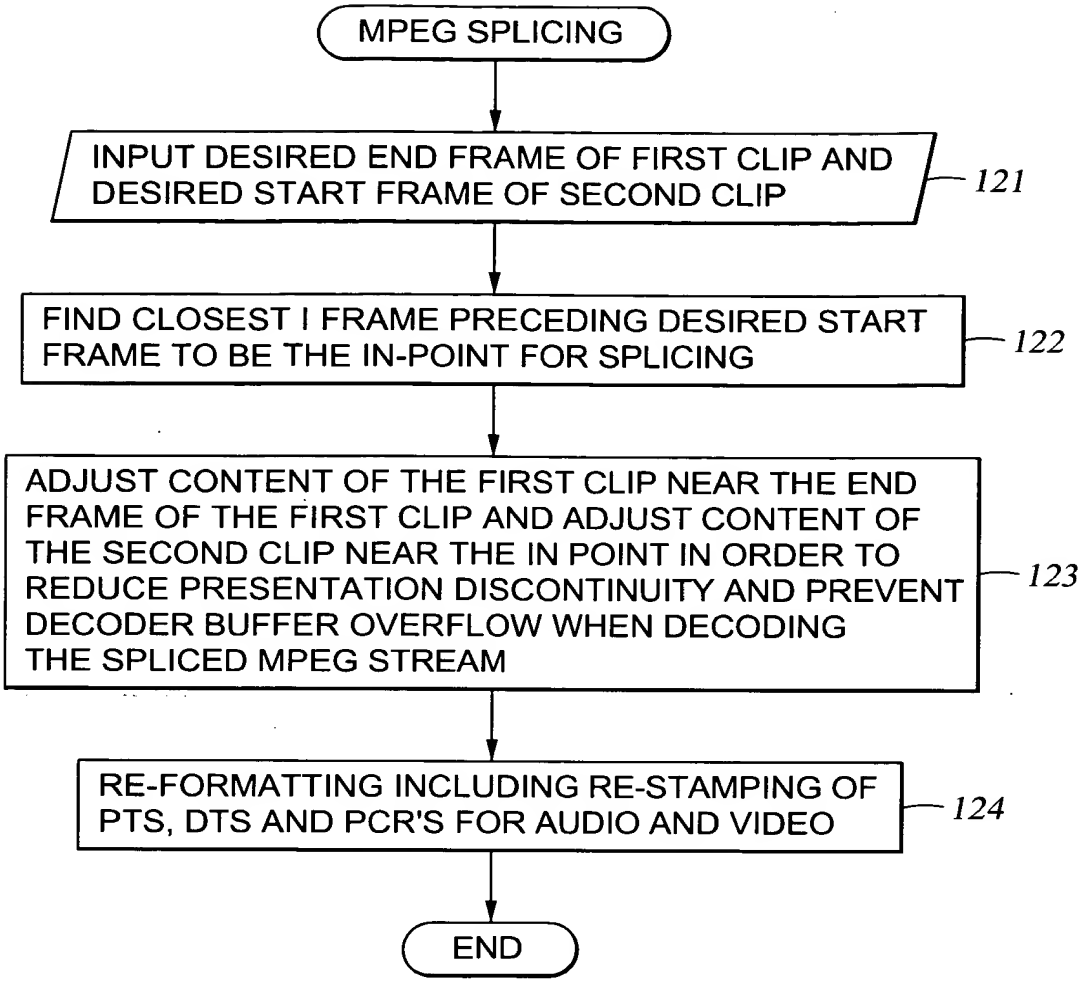

MPEG SPLICING
INPUT DESIRED END FRAME OF FIRST CLIP AND DESIRED START FRAME OF SECOND CLIP
121
FIND CLOSEST I FRAME PRECEDING DESIRED START FRAME TO BE THE IN-POINT FOR SPLICING
122
ADJUST CONTENT OF THE FIRST CLIP NEAR THE END FRAME OF THE FIRST CLIP AND ADJUST CONTENT OF THE SECOND CLIP NEAR THE IN POINT IN ORDER TO REDUCE PRESENTATION DISCONTINUITY AND PREVENT DECODER BUFFER OVERFLOW WHEN DECODING THE SPLICED MPEG STREAM
123
RE-FORMATTING INCLUDING RE-STAMPING OF PTS, DTS AND PCR'S FOR AUDIO AND VIDEO
124
END

Fig. 3

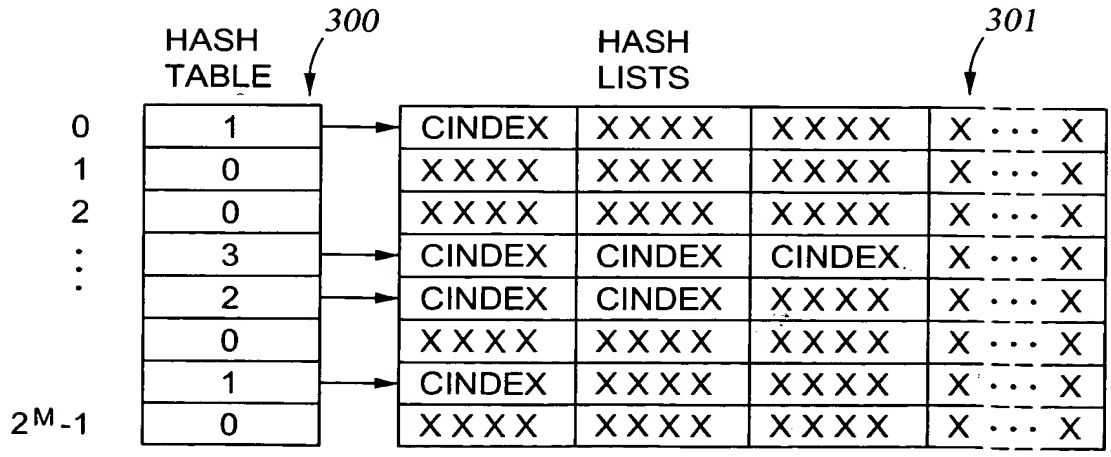

HASH TABLE
300
HASH LISTS
301
0
1
2
2M-1
1
0
0
3
2
0
1
0
CINDEX XXXX XXXX X ··· X
XXXX XXXX XXXX X ··· X
XXXX XXXX XXXX X ··· X
CINDEX CINDEX CINDEX X ··· X
CINDEX CINDEX XXXX X ··· X
XXXX XXXX XXXX X ··· X
CINDEX XXXX XXXX X ··· X
XXXX XXXX XXXX X ··· X

Fig. 18

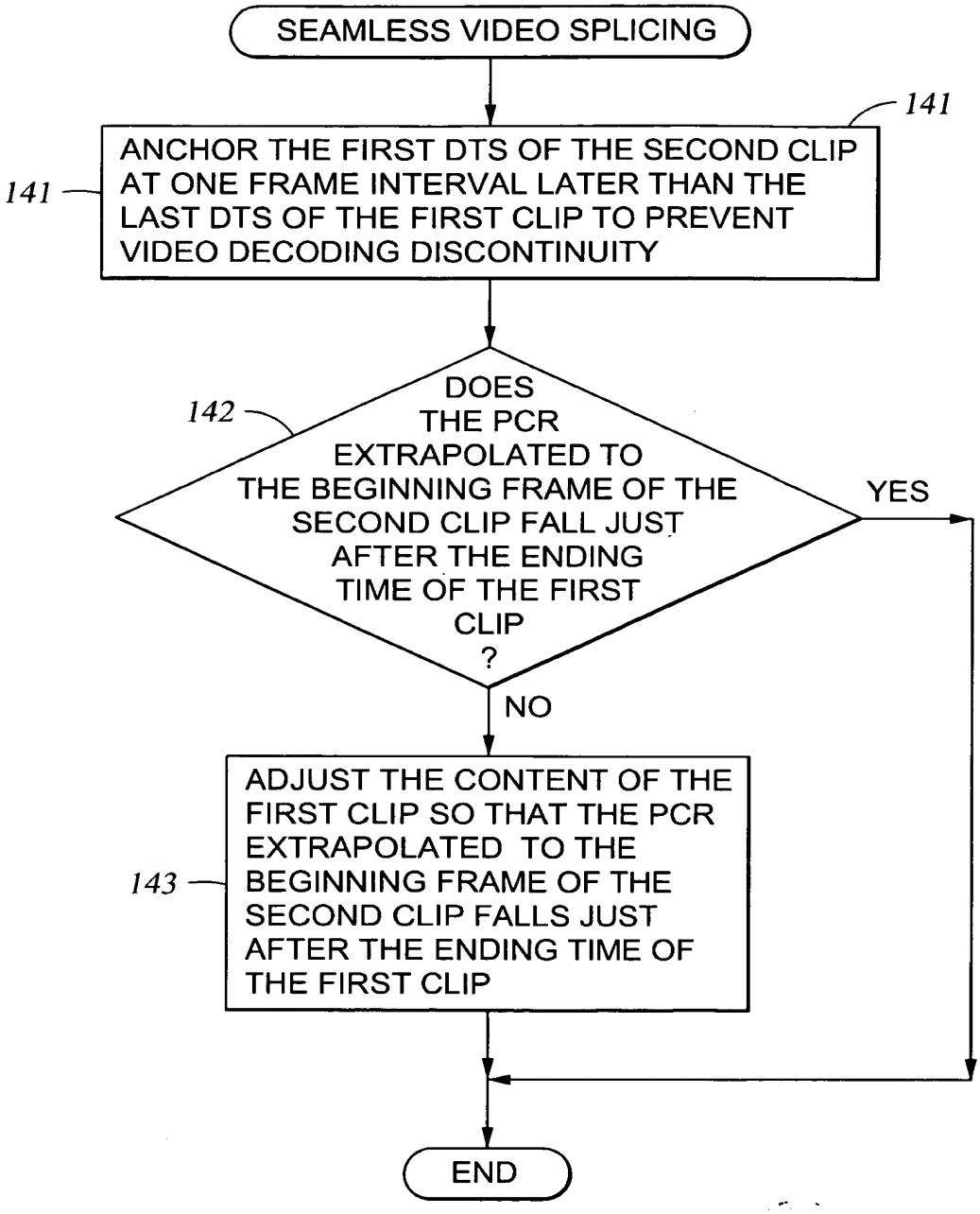

SEAMLESS VIDEO SPLICING
141
ANCHOR THE FIRST DTS OF THE SECOND CLIP AT ONE FRAME INTERVAL LATER THAN THE LAST DTS OF THE FIRST CLIP TO PREVENT VIDEO DECODING DISCONTINUITY
141
142
DOES THE PCR EXTRAPOLATED TO THE BEGINNING FRAME OF THE SECOND CLIP FALL JUST AFTER THE ENDING TIME OF THE FIRST CLIP ?
YES
NO
143
ADJUST THE CONTENT OF THE FIRST CLIP SO THAT THE PCR EXTRAPOLATED TO THE BEGINNING FRAME OF THE SECOND CLIP FALLS JUST AFTER THE ENDING TIME OF THE FIRST CLIP
END

Fig. 4

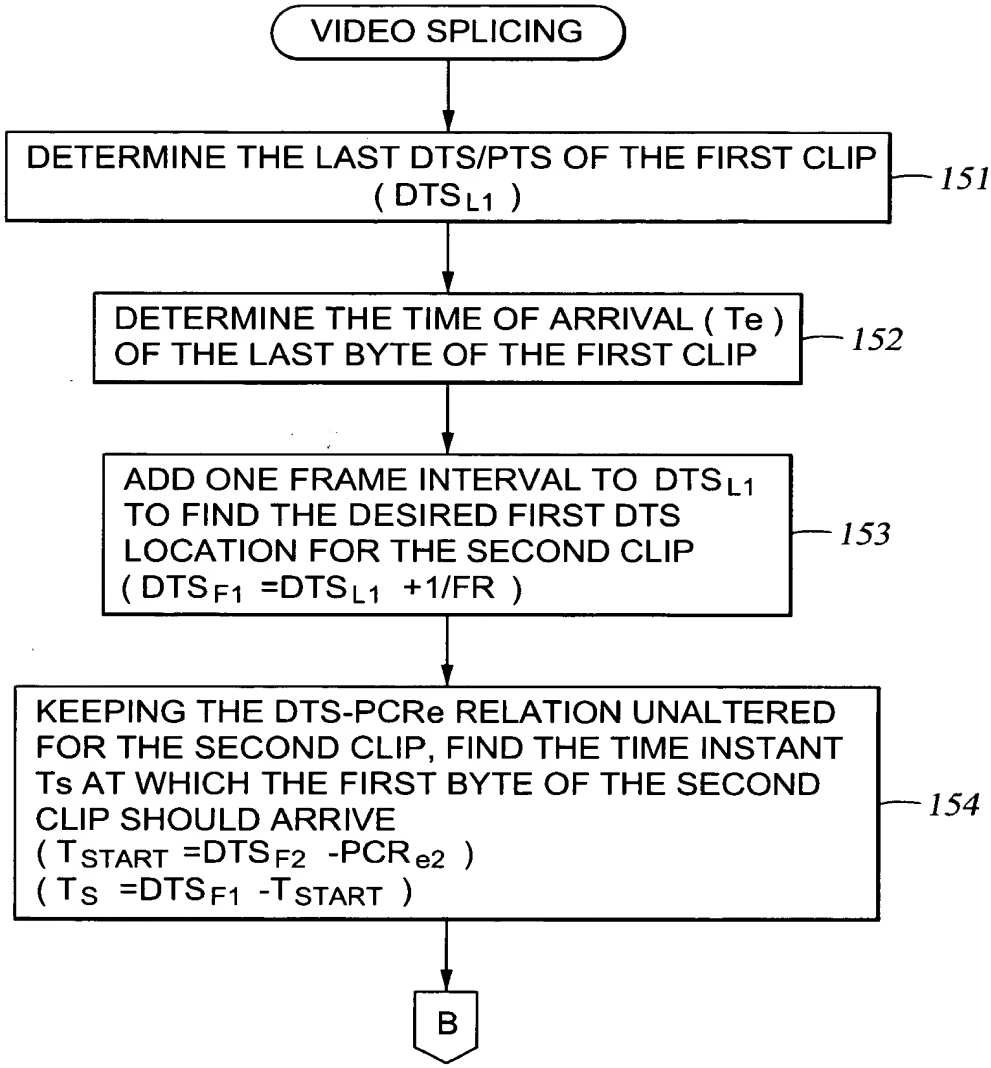

VIDEO SPLICING
DETERMINE THE LAST DTS/PTS OF THE FIRST CLIP
(DTS$_{L1}$)
151
DETERMINE THE TIME OF ARRIVAL (Te)
OF THE LAST BYTE OF THE FIRST CLIP
152
ADD ONE FRAME INTERVAL TO DTS$_{L1}$
TO FIND THE DESIRED FIRST DTS
LOCATION FOR THE SECOND CLIP
(DTS$_{F1}$ =DTS$_{L1}$ +1/FR)
153
KEEPING THE DTS-PCRe RELATION UNALTERED
FOR THE SECOND CLIP, FIND THE TIME INSTANT
Ts AT WHICH THE FIRST BYTE OF THE SECOND
CLIP SHOULD ARRIVE
(T$_{START}$ =DTS$_{F2}$ -PCR$_{e2}$)
(T$_S$ =DTS$_{F1}$ -T$_{START}$)
154
B

Fig. 5

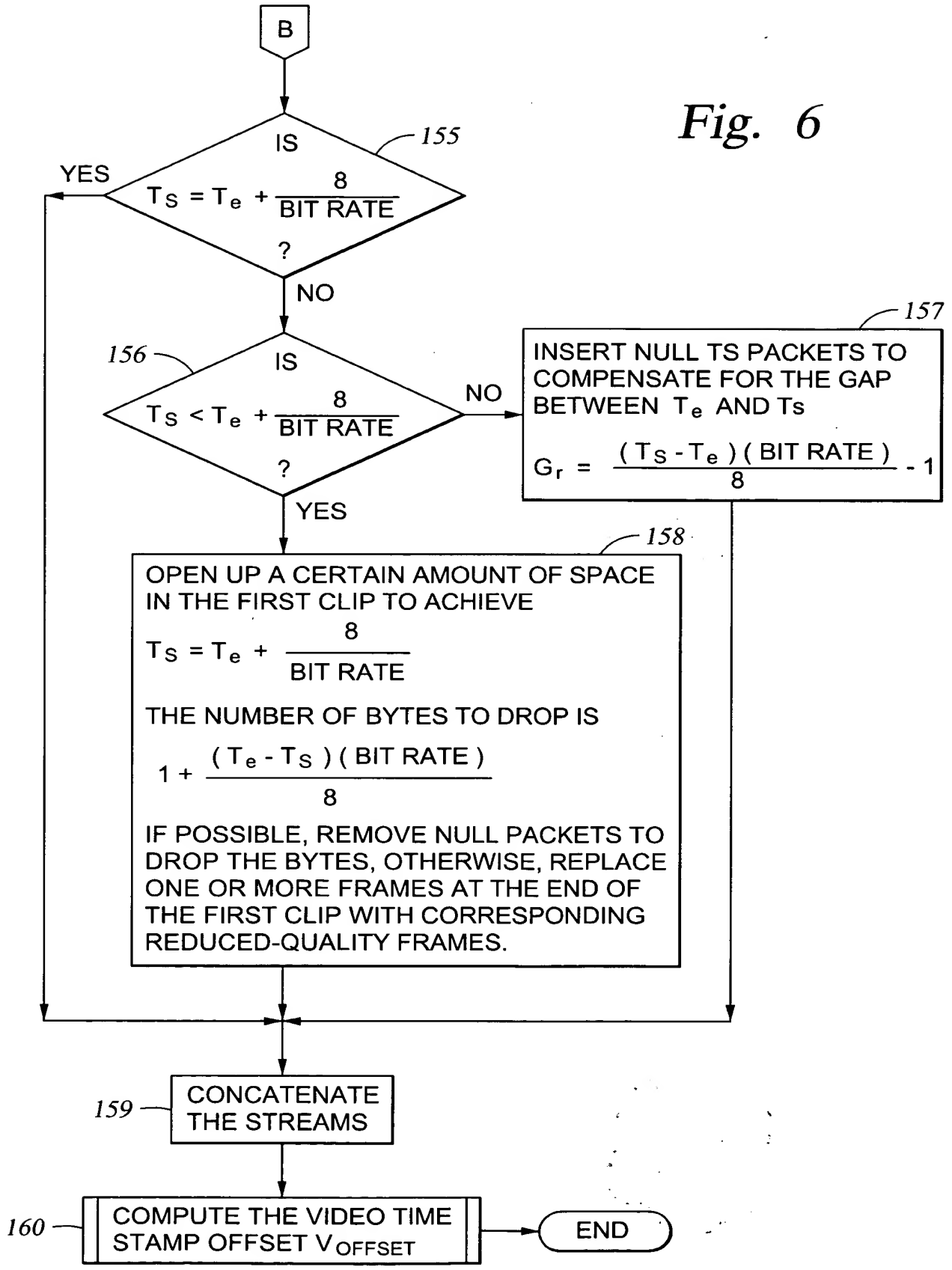

B
IS
155
YES
$T_S = T_e + \frac{8}{\text{BIT RATE}}$
?
NO
157
156
IS
NO
INSERT NULL TS PACKETS TO COMPENSATE FOR THE GAP BETWEEN T_e AND Ts
$T_S < T_e + \frac{8}{\text{BIT RATE}}$
?
$G_r = \frac{(T_S - T_e)(\text{BIT RATE})}{8} - 1$
YES
158
OPEN UP A CERTAIN AMOUNT OF SPACE IN THE FIRST CLIP TO ACHIEVE
$T_S = T_e + \frac{8}{\text{BIT RATE}}$
THE NUMBER OF BYTES TO DROP IS
$1 + \frac{(T_e - T_S)(\text{BIT RATE})}{8}$
IF POSSIBLE, REMOVE NULL PACKETS TO DROP THE BYTES, OTHERWISE, REPLACE ONE OR MORE FRAMES AT THE END OF THE FIRST CLIP WITH CORRESPONDING REDUCED-QUALITY FRAMES.
159
CONCATENATE THE STREAMS
160
COMPUTE THE VIDEO TIME STAMP OFFSET V_{OFFSET}
END

Fig. 6

Fig. 7

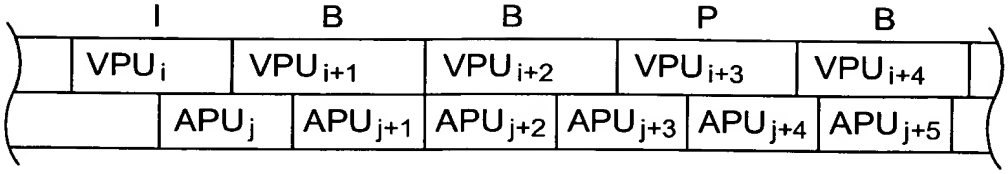
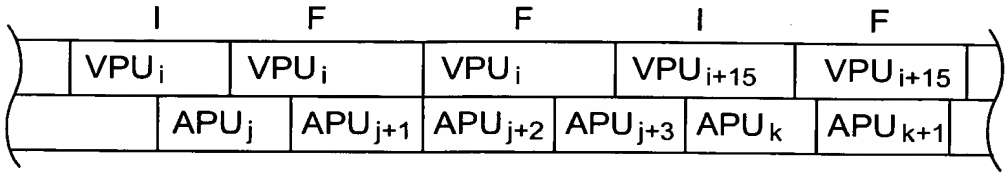


Fig. 8



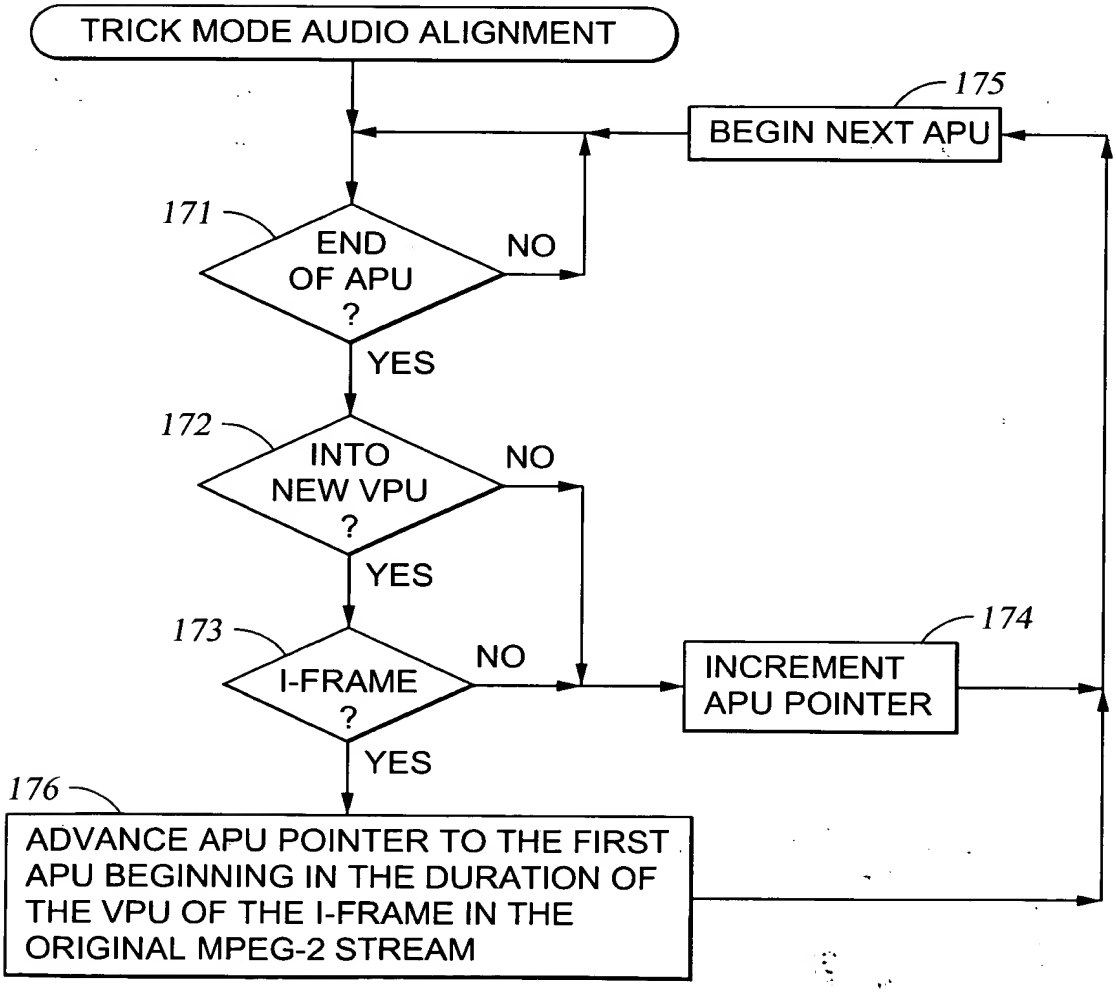


Fig. 9

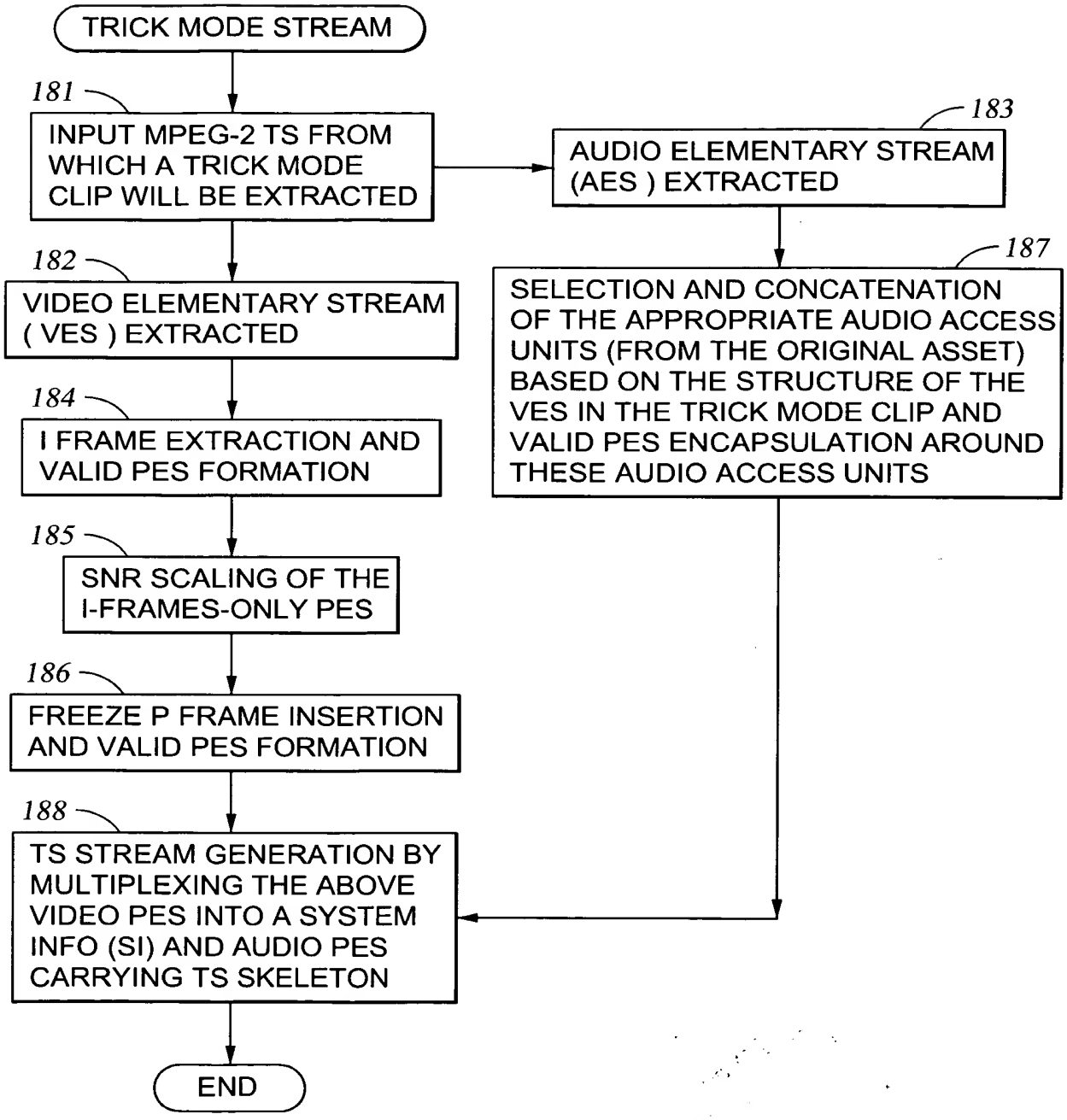

TRICK MODE STREAM
181
INPUT MPEG-2 TS FROM WHICH A TRICK MODE CLIP WILL BE EXTRACTED
183
AUDIO ELEMENTARY STREAM (AES) EXTRACTED
182
VIDEO ELEMENTARY STREAM (VES) EXTRACTED
187
SELECTION AND CONCATENATION OF THE APPROPRIATE AUDIO ACCESS UNITS (FROM THE ORIGINAL ASSET) BASED ON THE STRUCTURE OF THE VES IN THE TRICK MODE CLIP AND VALID PES ENCAPSULATION AROUND THESE AUDIO ACCESS UNITS
184
I FRAME EXTRACTION AND VALID PES FORMATION
185
SNR SCALING OF THE I-FRAMES-ONLY PES
186
FREEZE P FRAME INSERTION AND VALID PES FORMATION
188
TS STREAM GENERATION BY MULTIPLEXING THE ABOVE VIDEO PES INTO A SYSTEM INFO (SI) AND AUDIO PES CARRYING TS SKELETON
END

Fig. 10

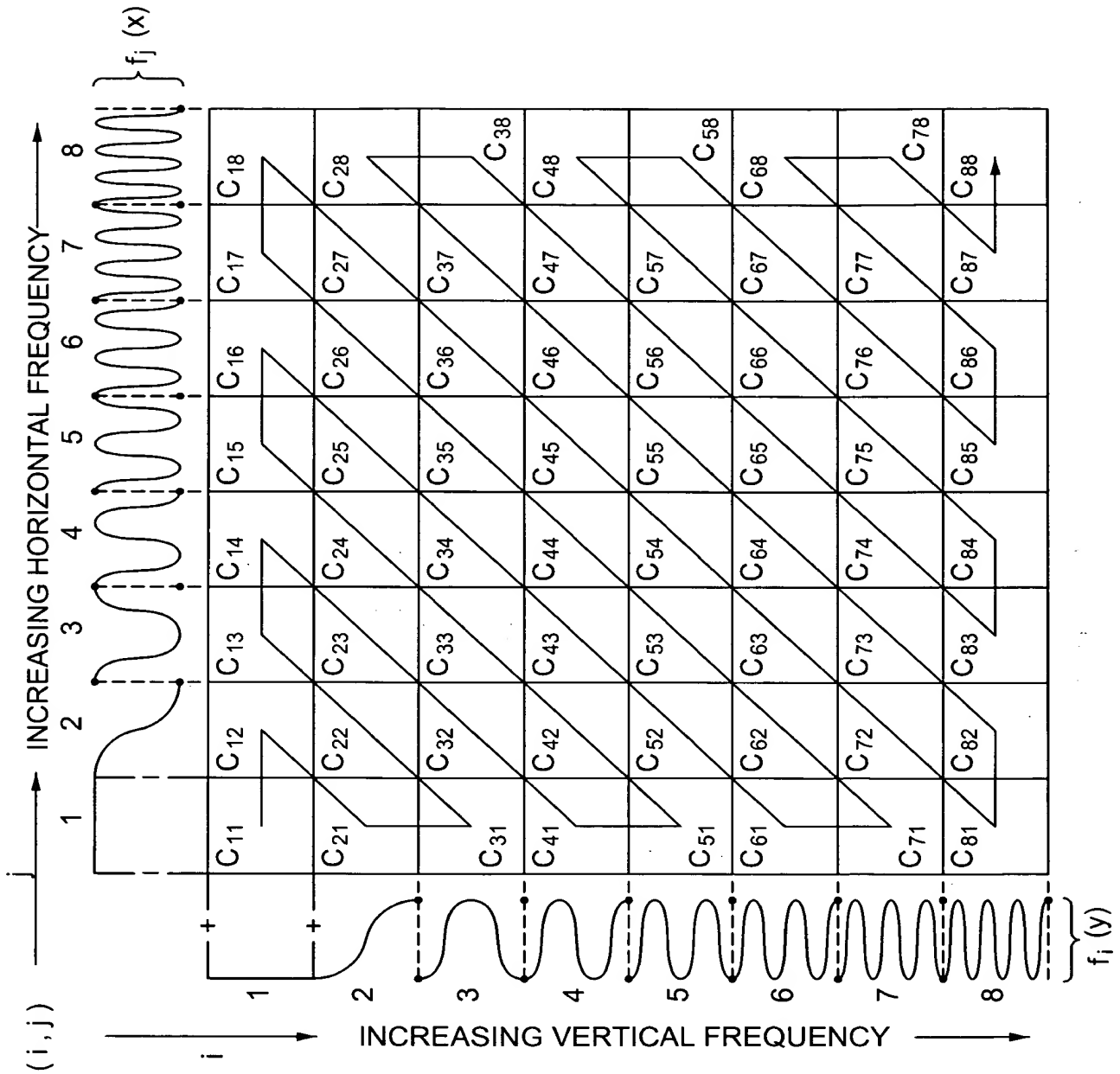


Fig. 11
(PRIOR ART)

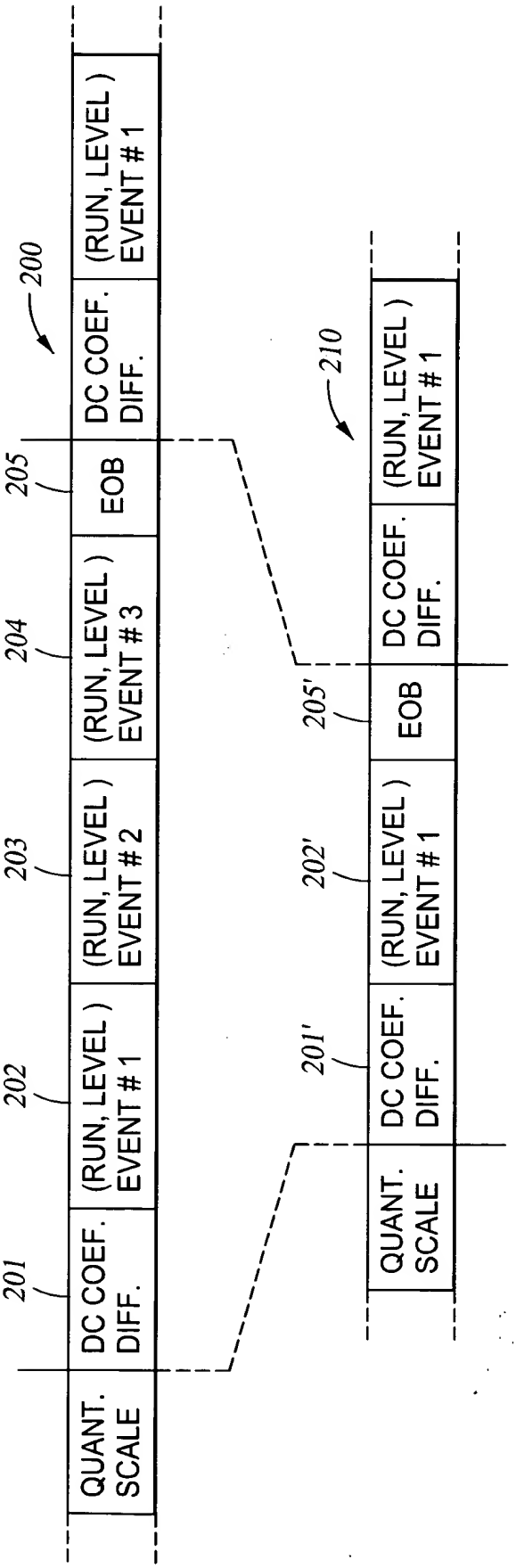

200
201
QUANT. SCALE
DC COEF. DIFF.
202
(RUN, LEVEL) EVENT # 1
203
(RUN, LEVEL) EVENT # 2
204
(RUN, LEVEL) EVENT # 3
205
EOB
DC COEF. DIFF.
(RUN, LEVEL) EVENT # 1
210
201'
QUANT. SCALE
DC COEF. DIFF.
202'
(RUN, LEVEL) EVENT # 1
205'
EOB
DC COEF. DIFF.
(RUN, LEVEL) EVENT # 1

Fig. 12

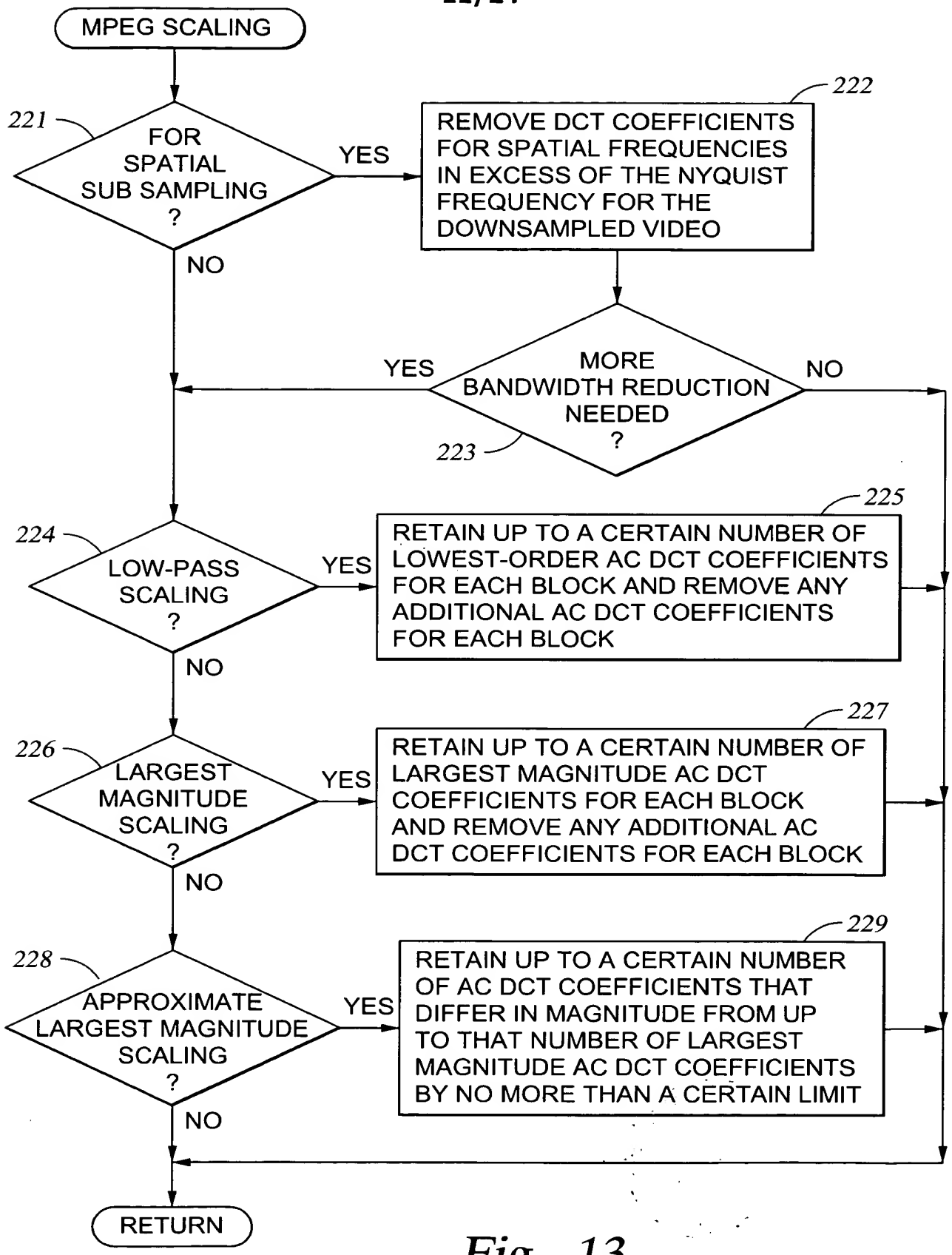

MPEG SCALING
221
FOR SPATIAL SUB SAMPLING ?
YES
222
REMOVE DCT COEFFICIENTS FOR SPATIAL FREQUENCIES IN EXCESS OF THE NYQUIST FREQUENCY FOR THE DOWNSAMPLED VIDEO
NO
YES
MORE BANDWIDTH REDUCTION NEEDED ?
223
NO
224
LOW-PASS SCALING ?
YES
225
RETAIN UP TO A CERTAIN NUMBER OF LOWEST-ORDER AC DCT COEFFICIENTS FOR EACH BLOCK AND REMOVE ANY ADDITIONAL AC DCT COEFFICIENTS FOR EACH BLOCK
NO
226
LARGEST MAGNITUDE SCALING ?
YES
227
RETAIN UP TO A CERTAIN NUMBER OF LARGEST MAGNITUDE AC DCT COEFFICIENTS FOR EACH BLOCK AND REMOVE ANY ADDITIONAL AC DCT COEFFICIENTS FOR EACH BLOCK
NO
228
APPROXIMATE LARGEST MAGNITUDE SCALING ?
YES
229
RETAIN UP TO A CERTAIN NUMBER OF AC DCT COEFFICIENTS THAT DIFFER IN MAGNITUDE FROM UP TO THAT NUMBER OF LARGEST MAGNITUDE AC DCT COEFFICIENTS BY NO MORE THAN A CERTAIN LIMIT
NO
RETURN

Fig. 13

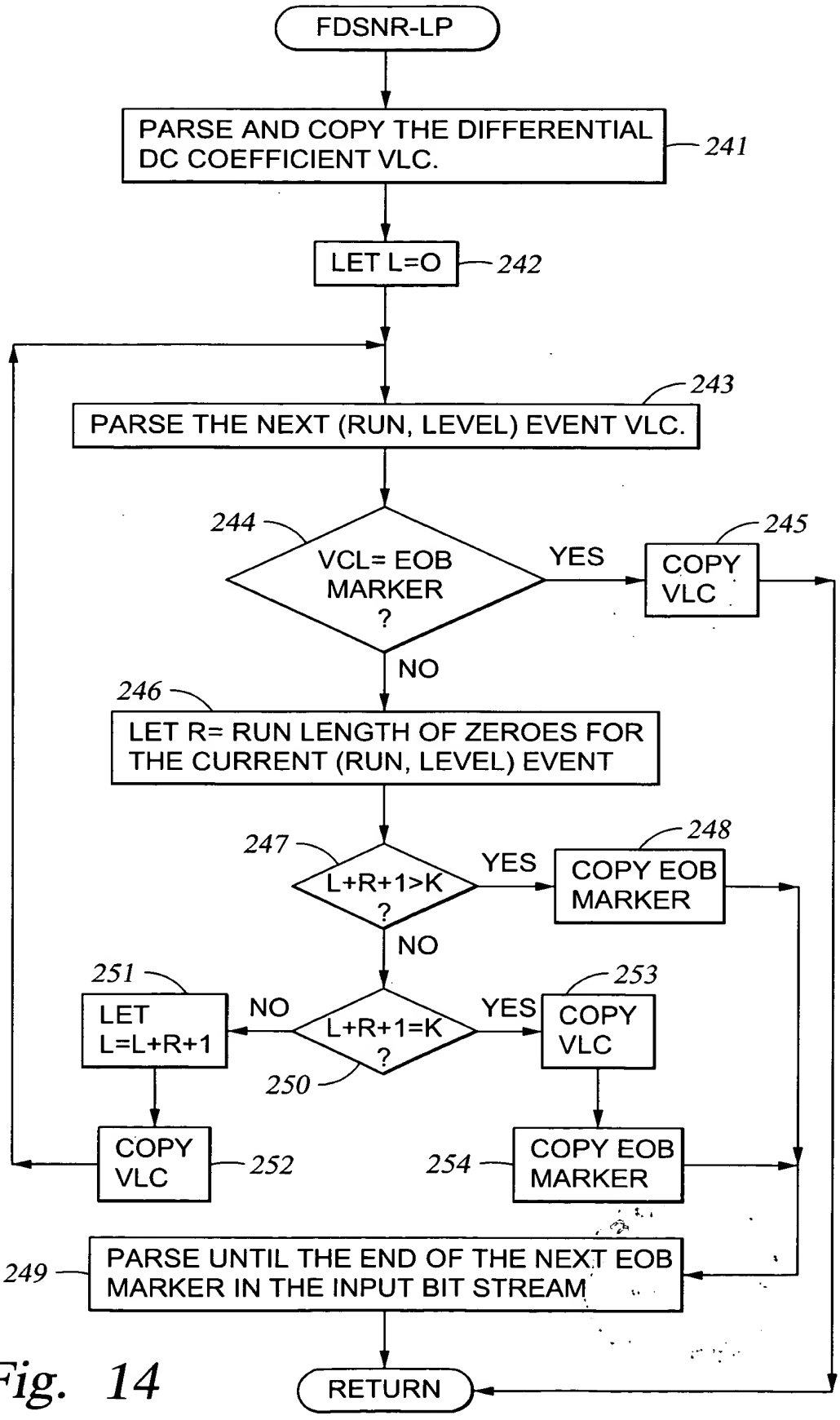

FDSNR-LP
PARSE AND COPY THE DIFFERENTIAL DC COEFFICIENT VLC.
241
LET L=O
242
243
PARSE THE NEXT (RUN, LEVEL) EVENT VLC.
244
VCL= EOB MARKER ?
YES
245
COPY VLC
NO
246
LET R= RUN LENGTH OF ZEROES FOR THE CURRENT (RUN, LEVEL) EVENT
247
L+R+1>K ?
YES
248
COPY EOB MARKER
NO
251
LET L=L+R+1
NO
L+R+1=K ?
YES
253
COPY VLC
250
COPY VLC
252
254
COPY EOB MARKER
249
PARSE UNTIL THE END OF THE NEXT EOB MARKER IN THE INPUT BIT STREAM
RETURN

Fig. 14

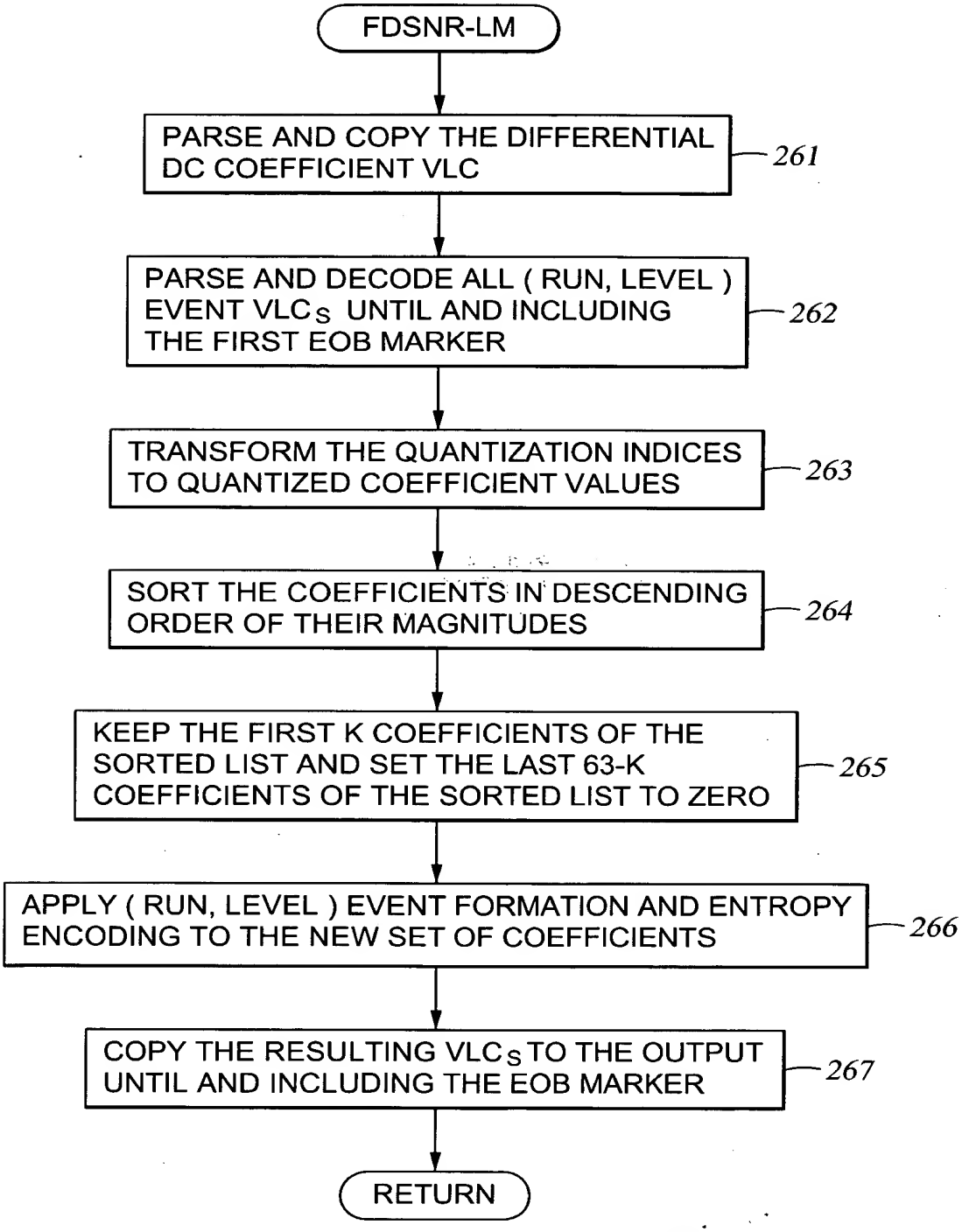

FDSNR-LM
PARSE AND COPY THE DIFFERENTIAL DC COEFFICIENT VLC
261
PARSE AND DECODE ALL (RUN, LEVEL) EVENT VLCS UNTIL AND INCLUDING THE FIRST EOB MARKER
262
TRANSFORM THE QUANTIZATION INDICES TO QUANTIZED COEFFICIENT VALUES
263
SORT THE COEFFICIENTS IN DESCENDING ORDER OF THEIR MAGNITUDES
264
KEEP THE FIRST K COEFFICIENTS OF THE SORTED LIST AND SET THE LAST 63-K COEFFICIENTS OF THE SORTED LIST TO ZERO
265
APPLY (RUN, LEVEL) EVENT FORMATION AND ENTROPY ENCODING TO THE NEW SET OF COEFFICIENTS
266
COPY THE RESULTING VLCS TO THE OUTPUT UNTIL AND INCLUDING THE EOB MARKER
267
RETURN

Fig. 15

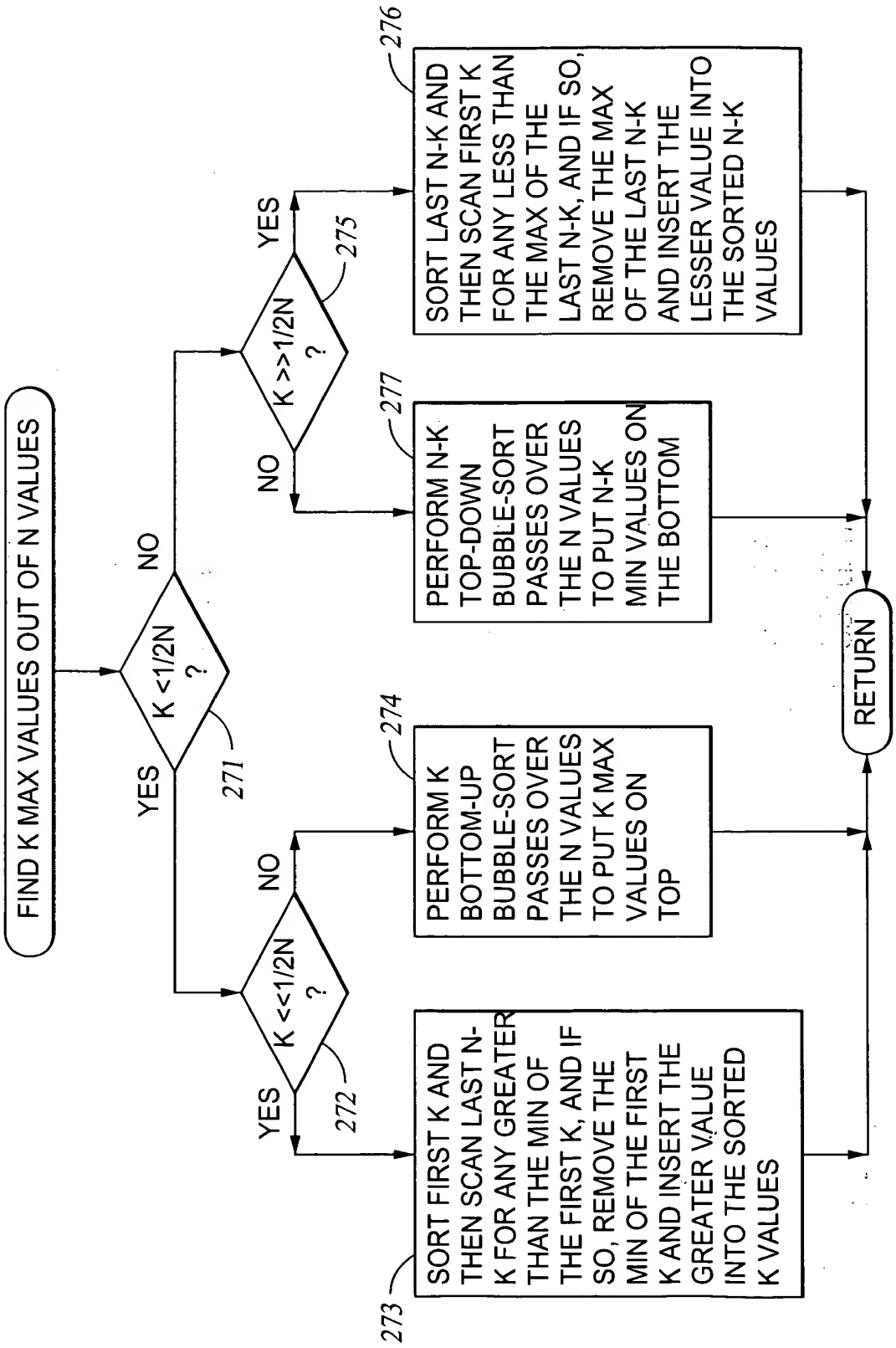

FIND K MAX VALUES OUT OF N VALUES
K <1/2N ?
271
YES
NO
K <<1/2N ?
272
YES
NO
SORT FIRST K AND THEN SCAN LAST N-K FOR ANY GREATER THAN THE MIN OF THE FIRST K, AND IF SO, REMOVE THE MIN OF THE FIRST K AND INSERT THE GREATER VALUE INTO THE SORTED K VALUES
273
PERFORM K BOTTOM-UP BUBBLE-SORT PASSES OVER THE N VALUES TO PUT K MAX VALUES ON TOP
274
K >>1/2N ?
275
YES
NO
SORT LAST N-K AND THEN SCAN FIRST K FOR ANY LESS THAN THE MAX OF THE LAST N-K, AND IF SO, REMOVE THE MAX OF THE LAST N-K AND INSERT THE LESSER VALUE INTO THE SORTED N-K VALUES
276
PERFORM N-K TOP-DOWN BUBBLE-SORT PASSES OVER THE N VALUES TO PUT N-K MIN VALUES ON THE BOTTOM
277
RETURN

Fig. 16

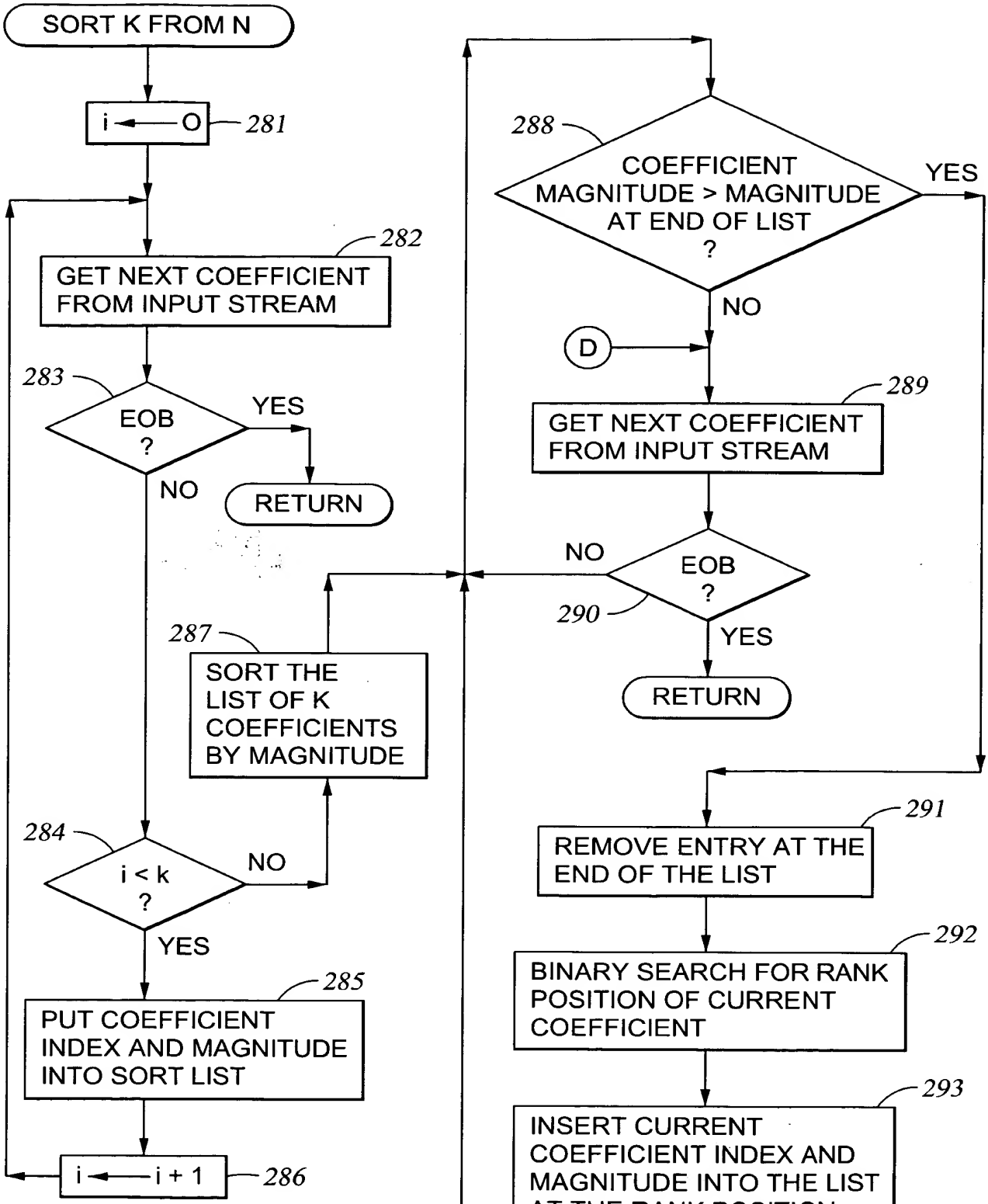

SORT K FROM N
i ← 0
281
GET NEXT COEFFICIENT FROM INPUT STREAM
282
EOB ?
283
YES
RETURN
NO
i < k ?
284
NO
YES
PUT COEFFICIENT INDEX AND MAGNITUDE INTO SORT LIST
285
i ← i + 1
286
SORT THE LIST OF K COEFFICIENTS BY MAGNITUDE
287
COEFFICIENT MAGNITUDE > MAGNITUDE AT END OF LIST ?
288
YES
NO
D
GET NEXT COEFFICIENT FROM INPUT STREAM
289
EOB ?
290
NO
YES
RETURN
REMOVE ENTRY AT THE END OF THE LIST
291
BINARY SEARCH FOR RANK POSITION OF CURRENT COEFFICIENT
292
INSERT CURRENT COEFFICIENT INDEX AND MAGNITUDE INTO THE LIST AT THE RANK POSITION
293

Fig. 17

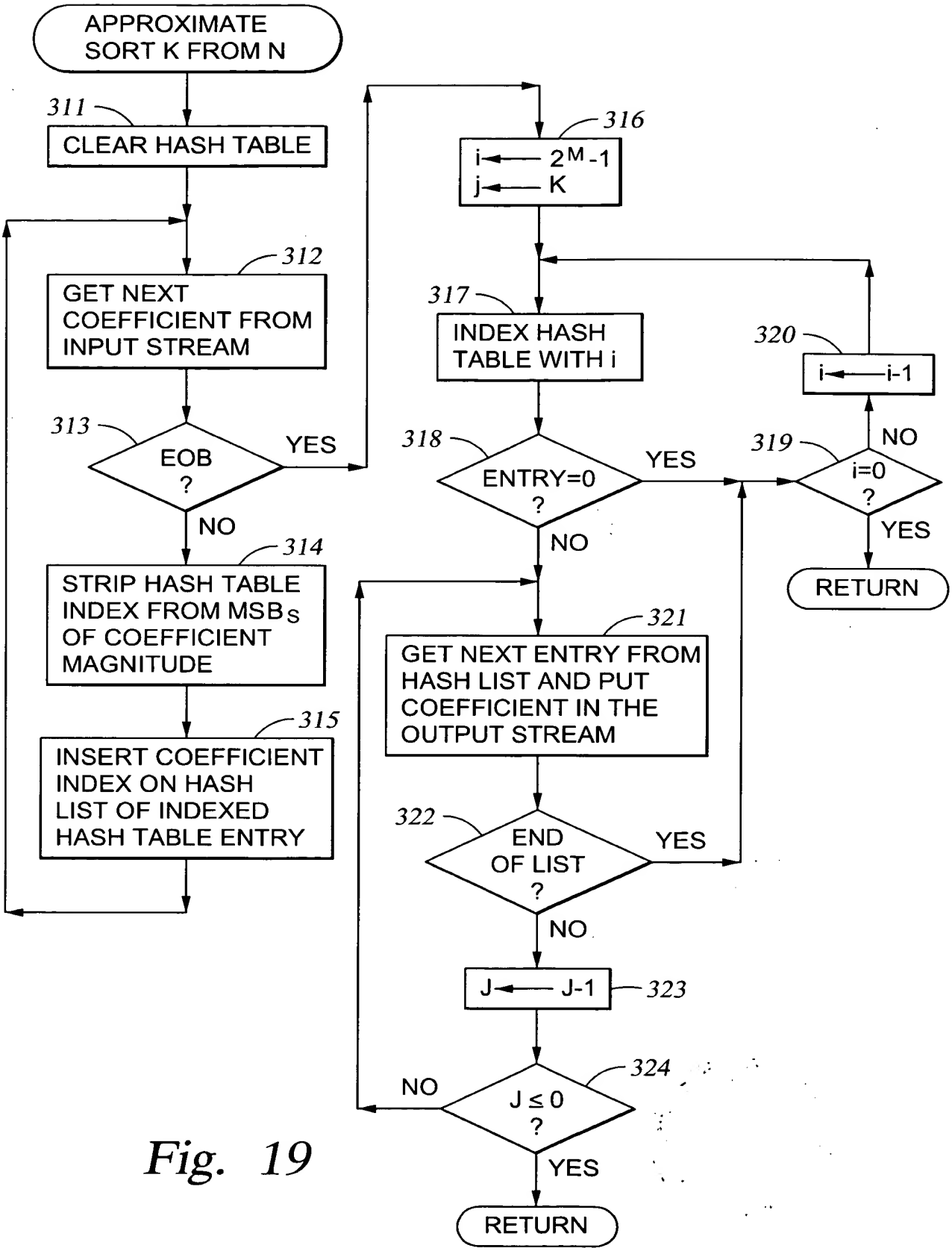

APPROXIMATE SORT K FROM N
311
CLEAR HASH TABLE
312
GET NEXT COEFFICIENT FROM INPUT STREAM
313
EOB ?
YES
NO
314
STRIP HASH TABLE INDEX FROM MSBs OF COEFFICIENT MAGNITUDE
315
INSERT COEFFICIENT INDEX ON HASH LIST OF INDEXED HASH TABLE ENTRY
316
i ← 2M-1
j ← K
317
INDEX HASH TABLE WITH i
318
ENTRY=0 ?
YES
NO
319
i=0 ?
NO
YES
320
i ← i-1
RETURN
321
GET NEXT ENTRY FROM HASH LIST AND PUT COEFFICIENT IN THE OUTPUT STREAM
322
END OF LIST ?
YES
NO
J ← J-1
323
324
J ≤ 0 ?
NO
YES
RETURN

Fig. 19

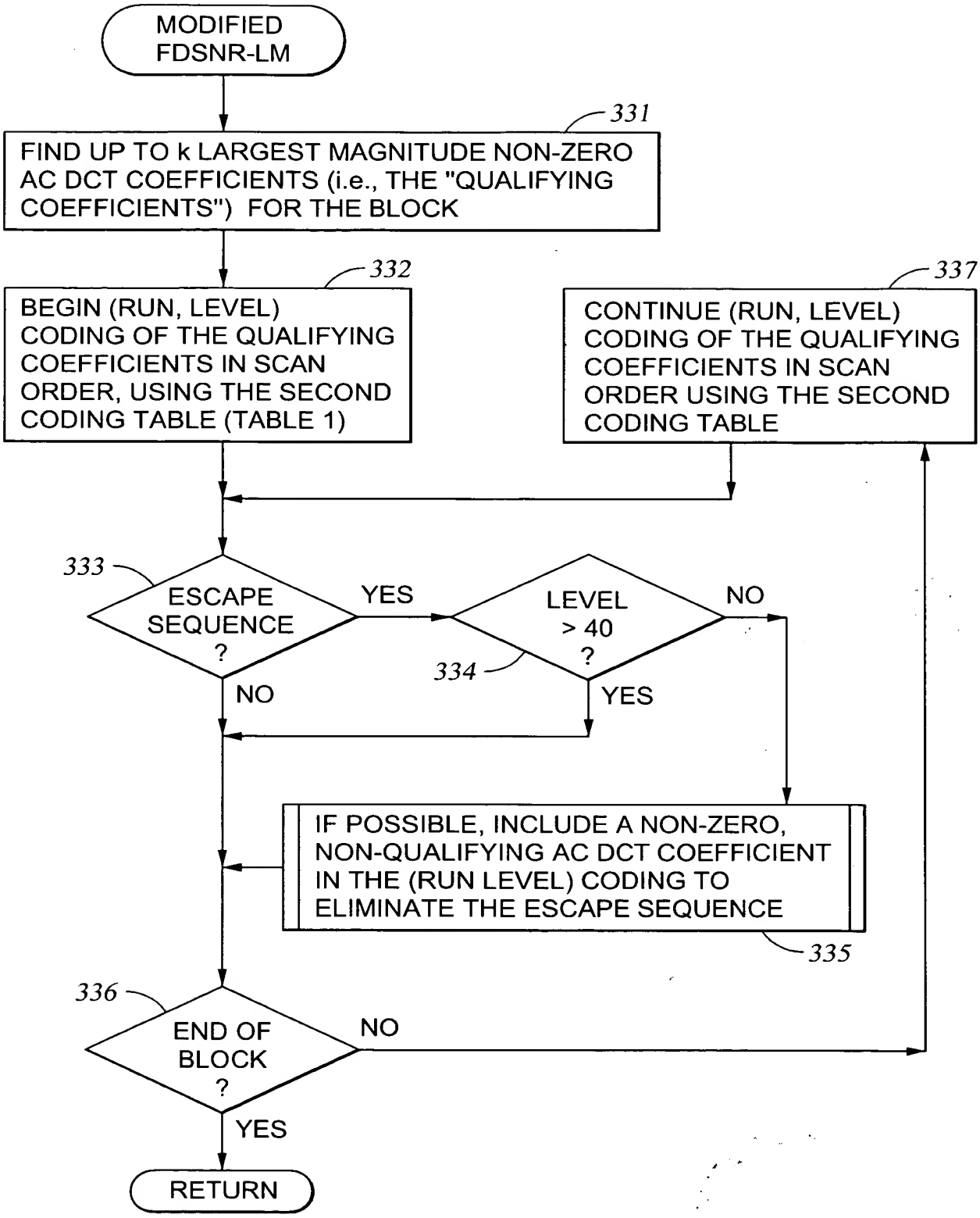

MODIFIED FDSNR-LM
331
FIND UP TO k LARGEST MAGNITUDE NON-ZERO AC DCT COEFFICIENTS (i.e., THE "QUALIFYING COEFFICIENTS") FOR THE BLOCK
332
BEGIN (RUN, LEVEL) CODING OF THE QUALIFYING COEFFICIENTS IN SCAN ORDER, USING THE SECOND CODING TABLE (TABLE 1)
337
CONTINUE (RUN, LEVEL) CODING OF THE QUALIFYING COEFFICIENTS IN SCAN ORDER USING THE SECOND CODING TABLE
333
ESCAPE SEQUENCE ?
YES
LEVEL > 40 ?
334
NO
NO
YES
IF POSSIBLE, INCLUDE A NON-ZERO, NON-QUALIFYING AC DCT COEFFICIENT IN THE (RUN LEVEL) CODING TO ELIMINATE THE ESCAPE SEQUENCE
335
336
END OF BLOCK ?
NO
YES
RETURN

Fig. 20

Fig. 21

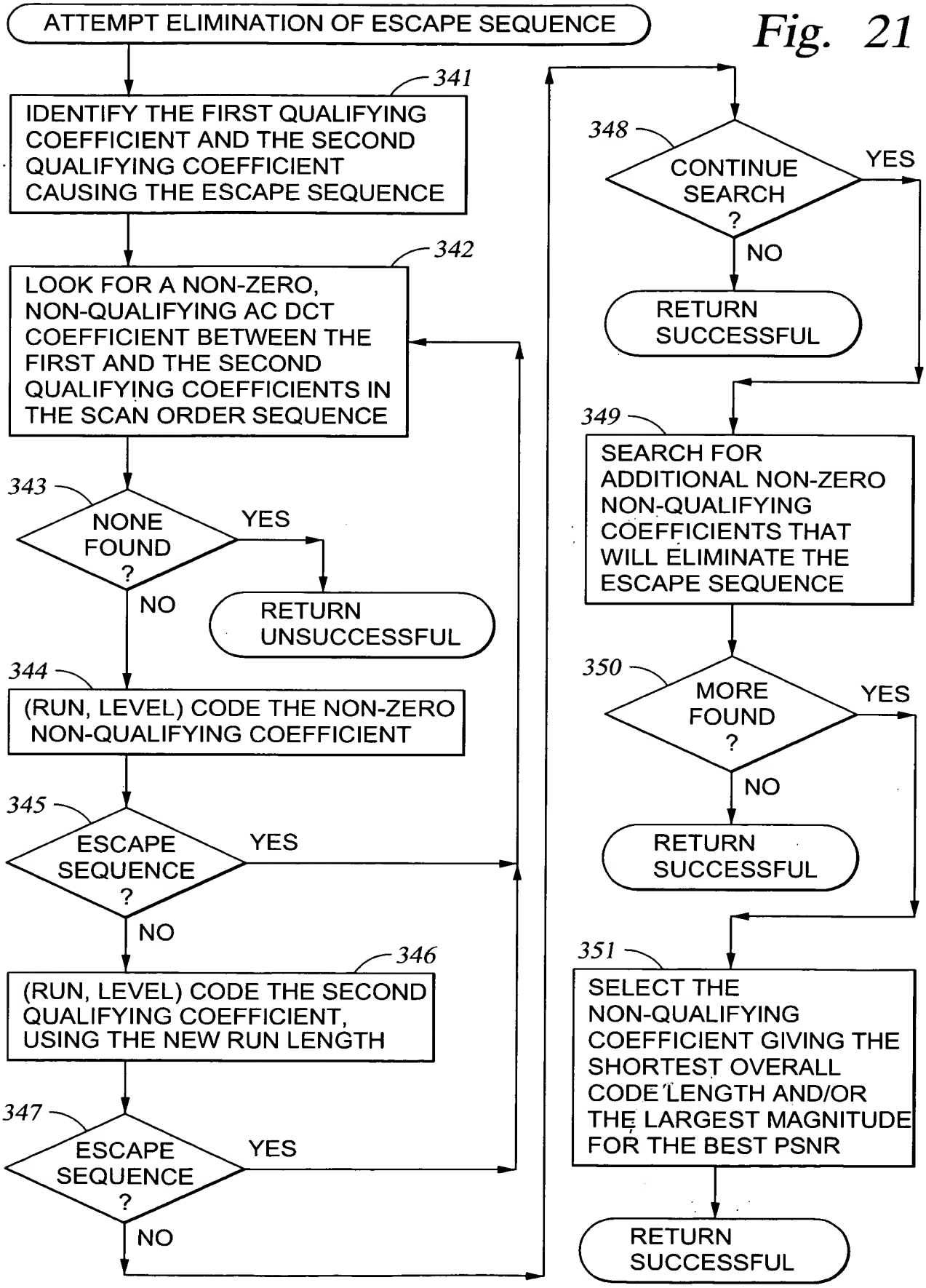

ATTEMPT ELIMINATION OF ESCAPE SEQUENCE
341
IDENTIFY THE FIRST QUALIFYING COEFFICIENT AND THE SECOND QUALIFYING COEFFICIENT CAUSING THE ESCAPE SEQUENCE
342
LOOK FOR A NON-ZERO, NON-QUALIFYING AC DCT COEFFICIENT BETWEEN THE FIRST AND THE SECOND QUALIFYING COEFFICIENTS IN THE SCAN ORDER SEQUENCE
343
NONE FOUND ?
YES
NO
RETURN UNSUCCESSFUL
344
(RUN, LEVEL) CODE THE NON-ZERO NON-QUALIFYING COEFFICIENT
345
ESCAPE SEQUENCE ?
YES
NO
346
(RUN, LEVEL) CODE THE SECOND QUALIFYING COEFFICIENT, USING THE NEW RUN LENGTH
347
ESCAPE SEQUENCE ?
YES
NO
348
CONTINUE SEARCH ?
YES
NO
RETURN SUCCESSFUL
349
SEARCH FOR ADDITIONAL NON-ZERO NON-QUALIFYING COEFFICIENTS THAT WILL ELIMINATE THE ESCAPE SEQUENCE
350
MORE FOUND ?
YES
NO
RETURN SUCCESSFUL
351
SELECT THE NON-QUALIFYING COEFFICIENT GIVING THE SHORTEST OVERALL CODE LENGTH AND/OR THE LARGEST MAGNITUDE FOR THE BEST PSNR
RETURN SUCCESSFUL

Fig. 22

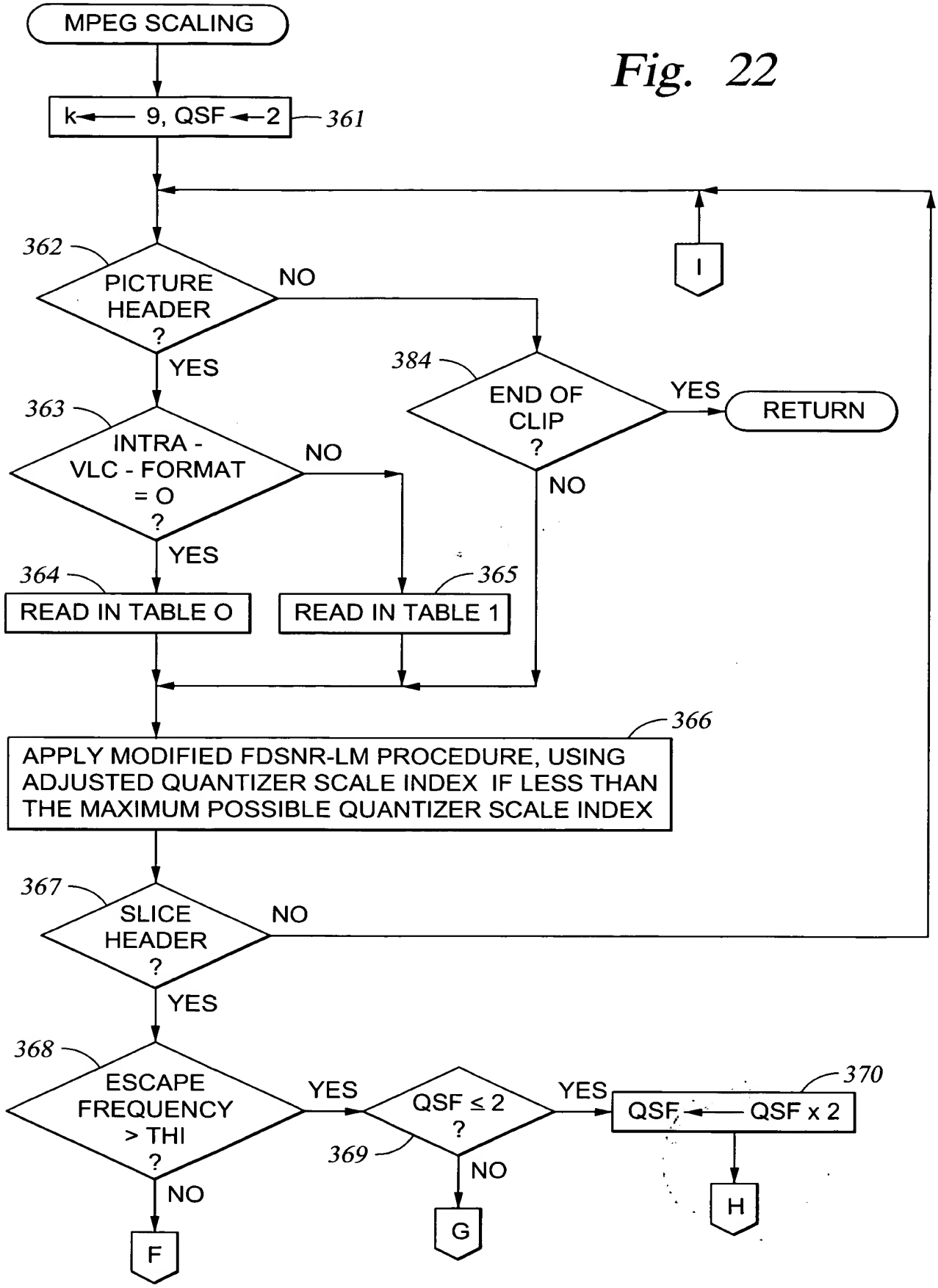
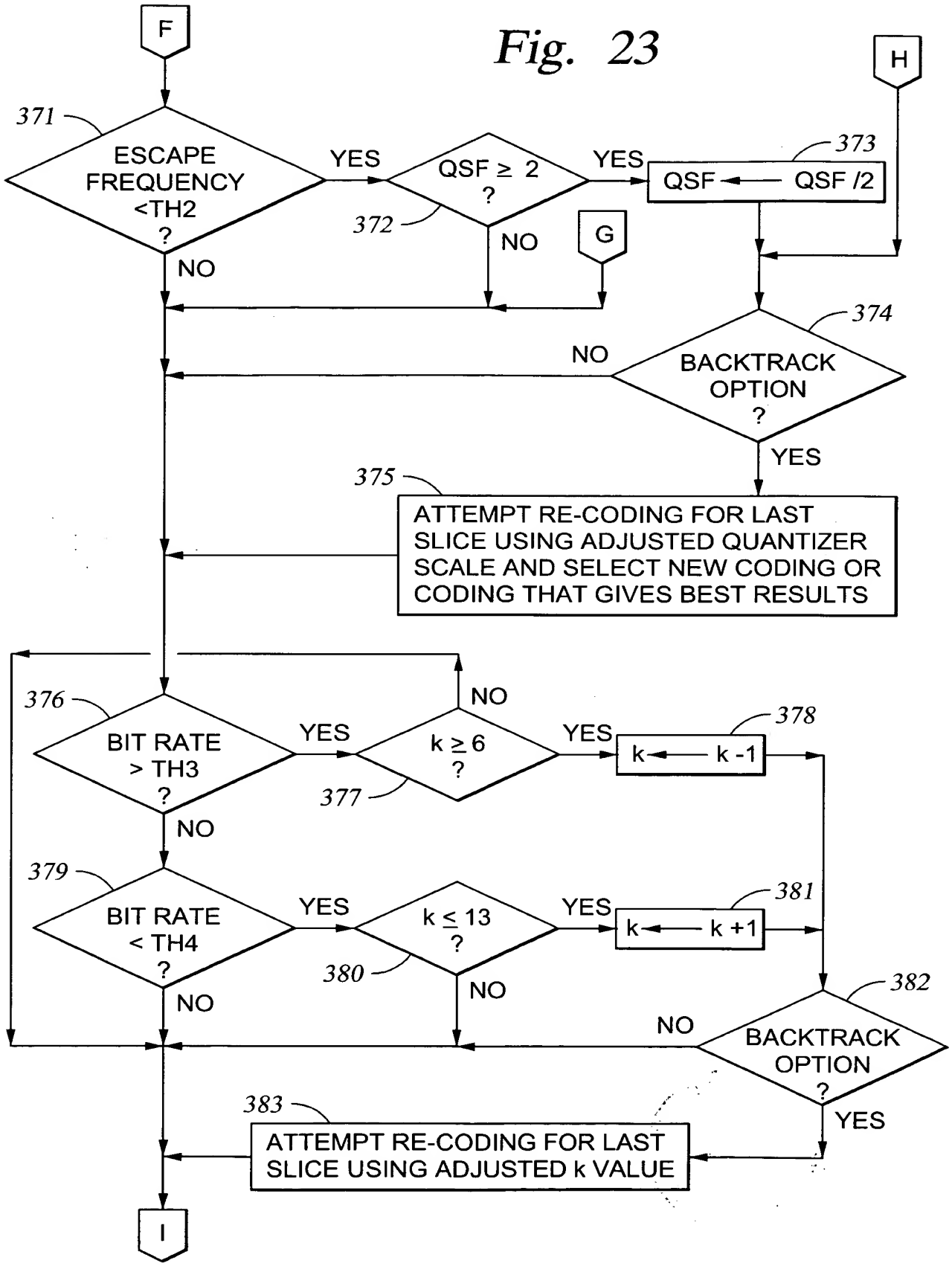

MPEG SCALING
k ← 9, QSF ← 2
361
362
PICTURE HEADER ?
NO
YES
I
384
END OF CLIP ?
YES
RETURN
NO
363
INTRA - VLC - FORMAT = O ?
NO
YES
364
READ IN TABLE O
365
READ IN TABLE 1
366
APPLY MODIFIED FDSNR-LM PROCEDURE, USING ADJUSTED QUANTIZER SCALE INDEX IF LESS THAN THE MAXIMUM POSSIBLE QUANTIZER SCALE INDEX
367
SLICE HEADER ?
NO
YES
368
ESCAPE FREQUENCY > THI ?
YES
QSF ≤ 2 ?
YES
370
QSF ← QSF x 2
369
NO
NO
H
G
F

Fig. 23


F
371
ESCAPE FREQUENCY <TH2 ?
YES
QSF ≥ 2 ?
372
YES
373
QSF ← QSF /2
H
NO
G
NO
374
BACKTRACK OPTION ?
NO
YES
375
ATTEMPT RE-CODING FOR LAST SLICE USING ADJUSTED QUANTIZER SCALE AND SELECT NEW CODING OR CODING THAT GIVES BEST RESULTS
376
BIT RATE > TH3 ?
YES
k ≥ 6 ?
377
NO
YES
378
k ← k -1
NO
379
BIT RATE < TH4 ?
YES
k ≤ 13 ?
380
YES
381
k ← k +1
NO
NO
382
BACKTRACK OPTION ?
NO
YES
383
ATTEMPT RE-CODING FOR LAST SLICE USING ADJUSTED k VALUE
I

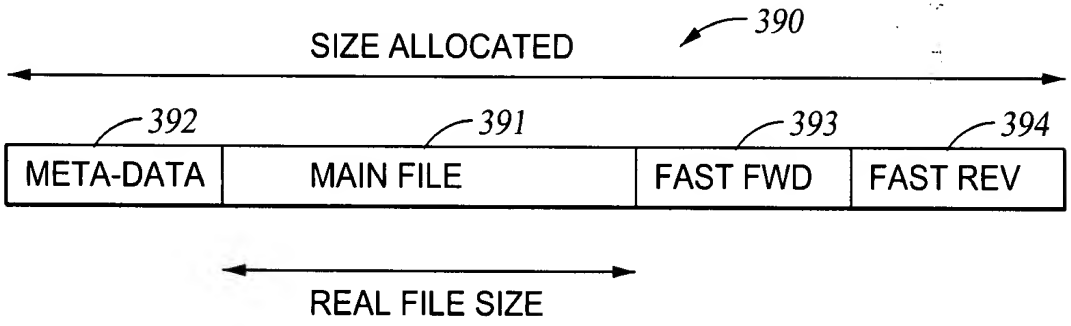

SIZE ALLOCATED
390
392
391
393
394
META-DATA
MAIN FILE
FAST FWD
FAST REV
REAL FILE SIZE

Fig. 24

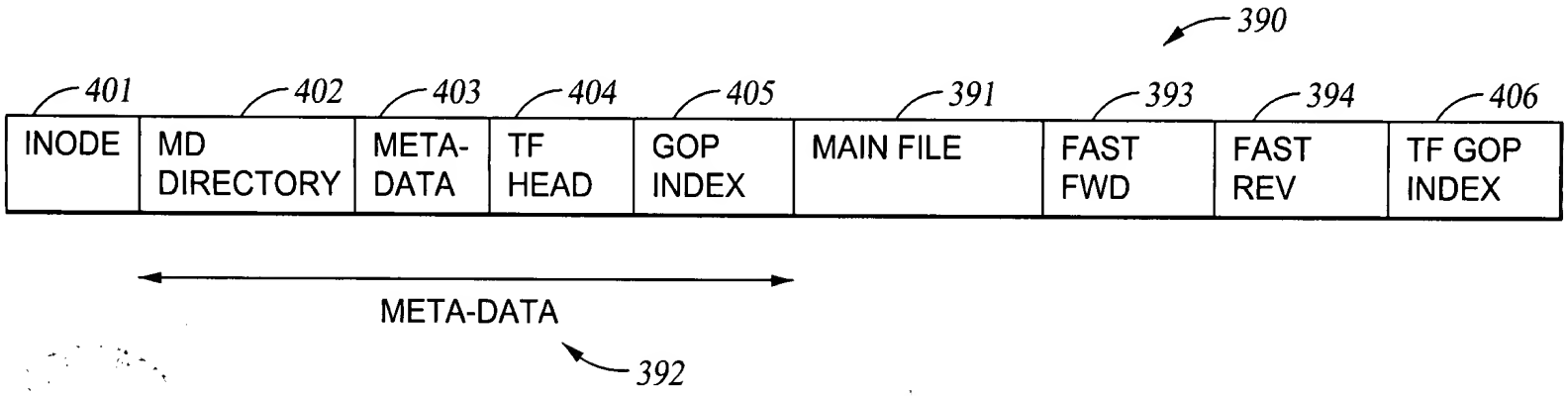

390
401
402
403
404
405
391
393
394
406
INODE
MD DIRECTORY
META-DATA
TF HEAD
GOP INDEX
MAIN FILE
FAST FWD
FAST REV
TF GOP INDEX
META-DATA
392

Fig. 25

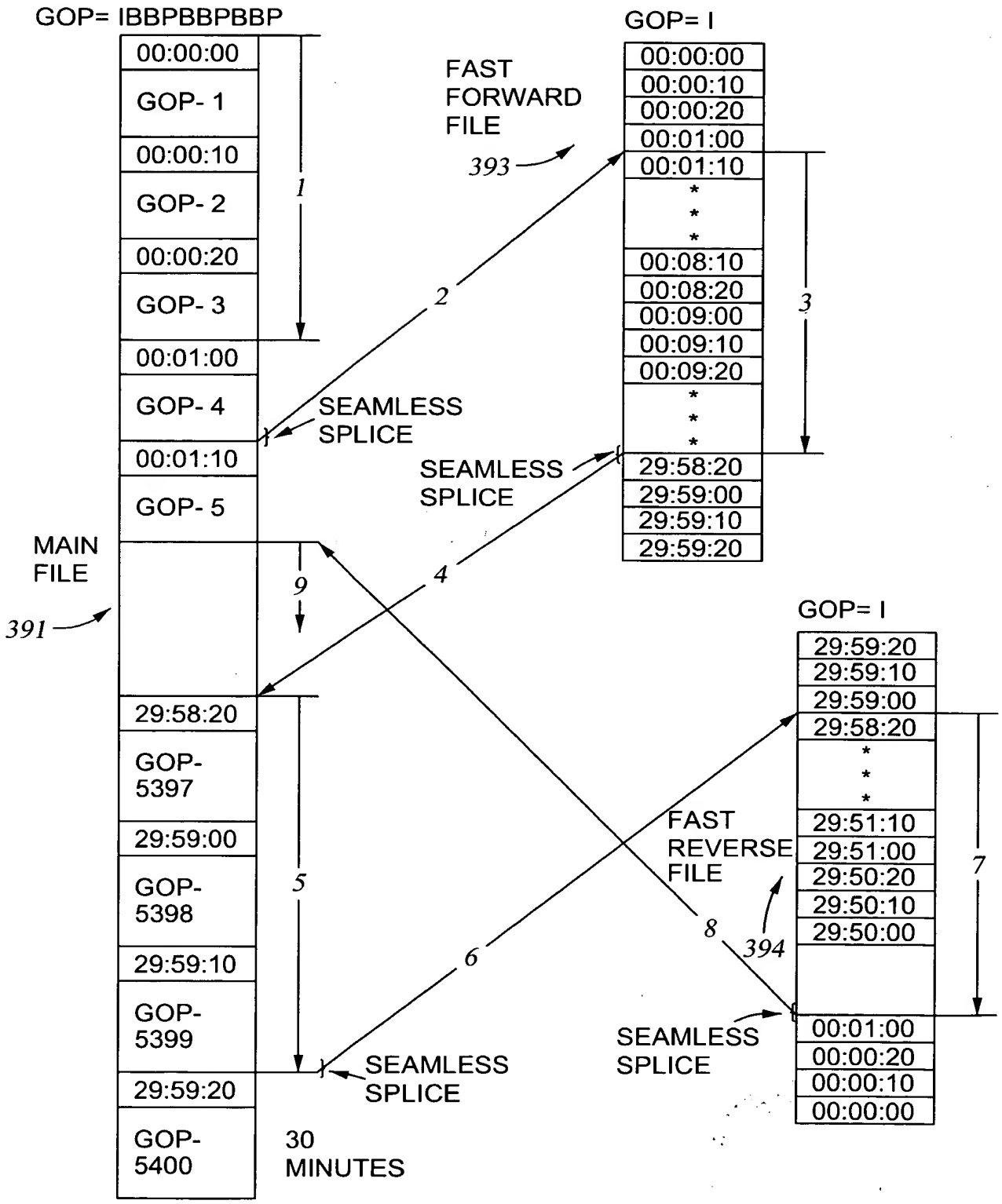

GOP= IBBPBBPBBP
00:00:00
GOP- 1
00:00:10
GOP- 2
00:00:20
GOP- 3
00:01:00
GOP- 4
00:01:10
GOP- 5
MAIN FILE
391
29:58:20
GOP- 5397
29:59:00
GOP- 5398
29:59:10
GOP- 5399
29:59:20
GOP- 5400
30 MINUTES
1
2
3
4
5
6
7
8
9
FAST FORWARD FILE
393
SEAMLESS SPLICE
SEAMLESS SPLICE
SEAMLESS SPLICE
GOP= I
00:00:00
00:00:10
00:00:20
00:01:00
00:01:10
00:08:10
00:08:20
00:09:00
00:09:10
00:09:20
29:58:20
29:59:00
29:59:10
29:59:20
GOP= I
29:59:20
29:59:10
29:59:00
29:58:20
29:51:10
29:51:00
29:50:20
29:50:10
29:50:00
00:01:00
00:00:20
00:00:10
00:00:00
FAST REVERSE FILE
394

Fig. 26A

Fig. 26B

1- Play from start 1 sec
2- Pause
3- Fast Forward to 29 min
4- Pause
5- Play 1 sec
6- Pause
7- Fast Reverse to 1 sec
8- Pause
9- Play Normal

	READ	WRITE
COPY OF THE ASSET WITH ALL THE DATA	EMPEG2	EMPEG2
COPY ONLY THE MAIN ASSET	RAW	MPEG2
ARCHIVE	EMPEG2	EMPEG2
PLAY	MPEG2	
RECORD		MPEG2

Fig. 27

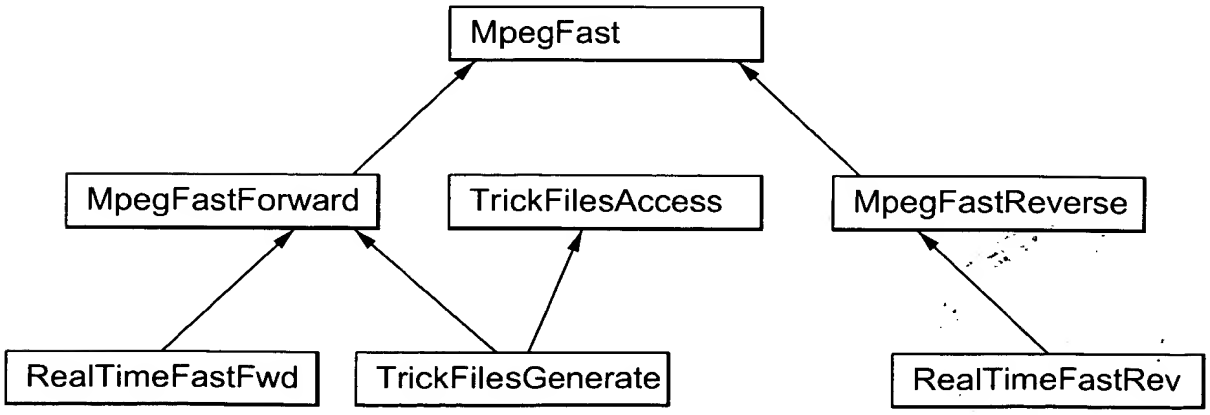


Fig. 28

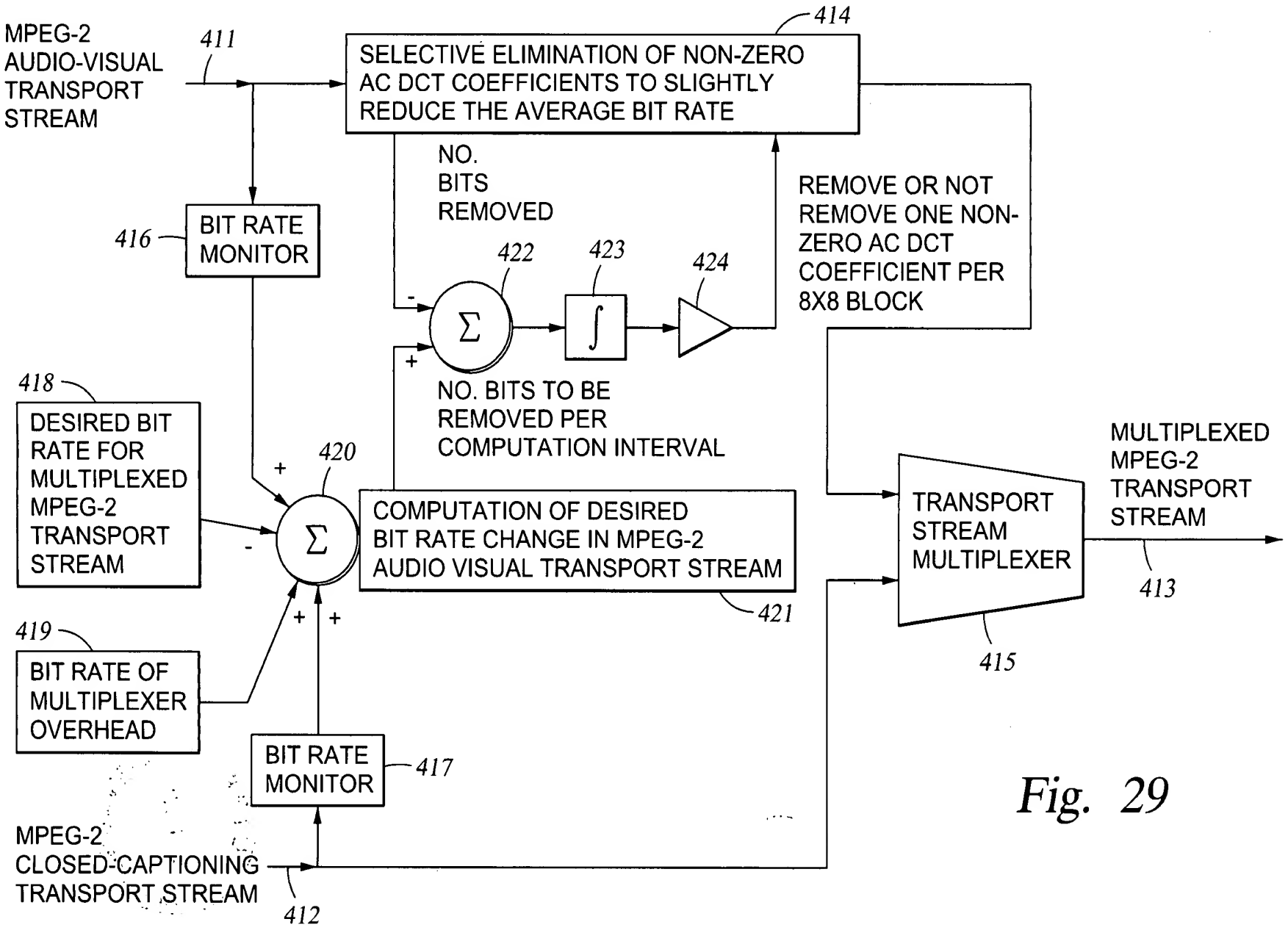

MPEG-2
AUDIO-VISUAL
TRANSPORT
STREAM
411
SELECTIVE ELIMINATION OF NON-ZERO
AC DCT COEFFICIENTS TO SLIGHTLY
REDUCE THE AVERAGE BIT RATE
414
NO.
BITS
REMOVED
REMOVE OR NOT
REMOVE ONE NON-
ZERO AC DCT
COEFFICIENT PER
8X8 BLOCK
416
BIT RATE
MONITOR
422
423
424
Σ
∫
NO. BITS TO BE
REMOVED PER
COMPUTATION INTERVAL
418
DESIRED BIT
RATE FOR
MULTIPLEXED
MPEG-2
TRANSPORT
STREAM
420
COMPUTATION OF DESIRED
BIT RATE CHANGE IN MPEG-2
AUDIO VISUAL TRANSPORT STREAM
421
TRANSPORT
STREAM
MULTIPLEXER
MULTIPLEXED
MPEG-2
TRANSPORT
STREAM
413
415
419
BIT RATE OF
MULTIPLEXER
OVERHEAD
BIT RATE
MONITOR
417
MPEG-2
CLOSED-CAPTIONING
TRANSPORT STREAM
412

Fig. 29